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ABSTRACT

This paper advances the argument favoring criterion-referenced/modular-based instruction (CRMBI) as applied to training and educational efforts in business, industrial, and military settings. CRMBI is defined as an instructional delivery system (along with the concomitant curriculum design and instructional materials development implications) that accommodates the following themes: (1) predetermined learner outcomes; (2) prerequisite learner background; (3) instructional sequencing; (4) criterion-referenced evaluation; and (5) flexible student entry and exit points. The proliferation of the professional literature in this area over the past 20 years points to increasing acceptance of CRMBI, in particular in teaching risk-oriented technical skills and in the multitude of diverse training situations to which CRMBI has been directed. Finally, a variation of CRMBI that is small group-based and flexibly teacher-paced is presented as an optimal instructional management tool that maximizes time flexibility for the student in a responsible way. A seven-page reference list is provided. (Author/KC)

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The Case for Criterion-Referenced/Modular-Based Instruction in Business, Industrial, and Military Settings

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Abstract

This paper advances the argument favoring criterion-referenced/modular-based instruction (CRMBI) as applied to training and educational efforts in business, industrial, and military settings. CRMBI is operationally defined as an instructional delivery system (along with the concomitant curriculum design and instructional materials development implications) that accommodates the themes of (a) predetermined learner outcomes, (b) prerequisite learner background, (c) instructional sequencing, (d) criterion-referenced evaluation, and (e) flexible student entry and exit points. The proliferation of the professional literature in this area over the past 20 years is examined, with particular attention given to risk-oriented technical skills and the multitude of diverse training situations to which CRMBI has been directed. Finally, a variation of CRMBI that is small group-based and flexibly teacher-paced is presented as an optimal instructional management tool that maximizes time flexibility for the student in a responsible way.

The Case for Criterion-Referenced/Modular-Based Instruction in Business, Industrial, and Military Settings

This paper attempts to advance the case for what has come to be known as criterion-referenced/modular-based instruction (CRMBI) as applied to training and educational efforts in business, industrial, and military settings.

The professional literature is quite replete with definitions/characterizations of what is meant by a criterion-referenced or modular-based approach to instruction (e.g.: Ainsworth, 1981; Hess & Sperry, 1973; Lanham, 1970; Popham, 1975; and Radway & Schroeder, 1978). Furthermore, it should be mentioned that at a somewhat broader level the notion of CRMBI is frequently subsumed under the more generic label of competency-based instruction/education (e.g.: Dejuozka & Kapel, 1982; Educational Resources Information Center, 1982; Hall & Jones, 1976; Hird, 1980; and Unwin & McAleese, 1978), which in turn is often viewed within the context of individualized instruction (e.g.: Kulik, 1982; Unwin & McAleese, 1978).

For our present purpose, the expression criterion-referenced/modular-based instruction (CRMBI) pertains to an instructional delivery system (and, by implication, a curriculum design and instructional materials development strategy) that (a) is predicated on predetermined learner outcomes and proficiency criteria, (b) accommodates the prerequisite knowledge/skills base required of the learner for success, (c) reflects a sequential

coverage of subject matter content and learning experiences in a linear and/or branching format, (d) evaluates student success in terms of performance standards rather than peer-group rank ordering, and (e) allows for flexible student entry and exit points in the instructional sequence on an individual or small group basis.

CRMBI in Business, Industrial, and Military Settings

The past 20 years have witnessed a proliferation of the professional literature available on the topic of CRMBI. The seminal work of Mager (1962), Gagne (1965), Banathy (1968), Mager and Pipe (1970), and Popham (1975) provided a generic basis from which applications of CRMBI have been made to training and educational programs in business, industrial, and military settings.

A recent computer search of the Educational Resources Information Center (ERIC) data base, for instance, uncovered a total of 107 journal articles and approximately 600 other types of research- and development-oriented documents that concern CRMBI applications in business, industry, and the armed services. Illustrative of this body of research in the business area, for example, are the contributions made by Brown (1977), Graham (1977), Brown (1980), Gryder and Gryder (1981), and Demaio and Ackley (1982); in the area of industry--Lockhart (1977),

Sussman (1978), Campbell (1980), Fey (1981), and Mager (1981); and in the armed services--Ford (1976), Raynor (1976), Bracco (1979), Ainsworth (1981), and Larson (1983). Of particular interest in this final area is the reference to Ainsworth (1981) who (a) traces the history of military efforts to systematize the design, development, installation, and operational training for a weapons system and (b) discusses the status of criterion-referenced instruction in Army training programs.

In addition to the several sources just cited, the application and consistent effectiveness of CRMBI in the aforementioned areas can be further documented. Figure 1 identifies 17 CRMBI citations from the literature over a span of the past seven years which (a) involve, for the most part, risk-oriented technical skills and (b) covers a multitude of diverse training situations not only in the armed services but also in other governmental-based agencies as well as the health sciences and vocationally-oriented programs. Particularly worthy of note here are the high-risk skill areas reported on by Widen (1982) in the setting of nuclear power plant personnel training, the West Virginia Department of Education (1981) in firefighter training, and Rankin and McDaniel (1980) in the area of aviator flight task proficiency.

In the category of military/governmental agencies, documents on CRMBI as applied to interservice military training (Berkowitz & O'Neil, 1979), the Federal Emergency Management Agency (Thomas,

Citation	Setting/Focus/Subjects
High-Risk Skill Areas	
Widen (1982)	Nuclear Power Plant Personnel Training
West Virginia Dept. of Education (1981)	Firefighter Training
Rankin and McDaniel (1980)	Aviator Flight Task Proficiency
Military/Governmental Agencies	
Berkowitz and O'Neil (1979)	Interservice Military Training
Thomas (1983)	Federal Emergency Management Agency
Campbell (1984)	Instructional Articulation among Military, Government, and Private Sector
Health Sciences	
Spotts (1979)	Emergency Medical Technicians
Mink (1981)	Armed Services Dental and Medical Training
Cave et al. (1983a)	Radiographic Aides
Cave et al. (1983b)	Respiratory Therapists
Buccelli (1981)	Medical Laboratory Technicians
Vocationally-Oriented Programs	
Watkins (1981)	Aviation Mechanics
Sloan and Hilley (1984)	Computer Numerically Controlled Turning Machines
Illinois State Board of of Education (1983)	Ethanol Spark Ignition Engine Conversion
Dunn (1981) and Mein et al. (1982)	Machine Trades
Keeton et al. (1983)	Agribusiness/Natural Resources Exploration

Figure 1. CRMBI literature citations spanning high-risk skill areas, military/governmental agencies, health sciences, & vocational areas.

1983), and the sharing of instructional processes and materials among the military, governmental, and private sector (Campbell, 1984) are available.

With regard to the health sciences, CRMBI is related to the training of emergency medical technicians (Spotts, 1979), armed services personnel in dentistry and medicine (Mink, 1981), radiographic aides (Cave et al., 1983a), respiratory therapists (Cave et al., 1983b), and medical laboratory technicians (Buccelli, 1981).

Finally, as regards the vocationally-oriented programs, CRMBI has been related to training in the following areas: aviation mechanics (Watkins, 1981), computer numerically controlled turning machines (Sloan & Hilley, 1984), ethanol spark ignition engine conversion (Illinois State Board of Education, 1983), machine trades (Dunn, 1981; Mein et al., 1982), and agribusiness/ natural resources exploration (Keeton et al., 1983).

Dynamics and Variations of CRMBI

Of course, the mere proliferation of literature citations associated with a particular instructional movement like CRMBI does not compellingly assure one of its efficacy--though such a trend might very well be interpreted as encouraging assurance that some value can perhaps be detected in it.

Instead, it is that set of dynamics--inclusive of practices and underlying principles--as well as variations of CRMBI that

one should appeal to for arguments favoring the appropriateness of this form of instructional delivery system. With this notion in mind, let us now focus our attention on the dynamics and variations of CRMBI.

Dynamics

As stated at the outset of this paper, the expression criterion-referenced/modular-based instruction is generically defined here as an instructional delivery system that (a) implies a certain strategy for curriculum design and instructional materials development and (b) encompasses the following five components:

1. It is predicated on predetermined learning outcomes and proficiency criteria. This component is provided explicitly by statements of performance objectives and/or implicitly by a detailed communication of subject matter content to be covered--both in the context of the required quantitative/qualitative standards to be met. The underlying principle here involves the desirability of creating for the learner an anticipatory set whereby the student is apprised of--and consequently entertains expectations of--those forms of behavior at certain competency levels that he/she will be capable of demonstrating once a given instructional sequence is completed.

2. It accommodates the prerequisite knowledge/skills base required of the learner for success. This second feature of CRMBI is addressed by way of identifying and/or assessing those basic

competencies from previous learning sequences that should have been mastered by the student and that represent the foundation upon which is based the new knowledge/skills sought in a subsequent instructional sequence (e.g., a specific module or an entire course). The governing principle here is found in (a) the empirical research of Bloom (1971, 1976) which suggests that 50% of the variance in student achievement is attributable to a deficient prerequisite background and (b) the rather common sense notion that learning, optimally, should proceed from that which the student currently knows to that which is nor presently known but will be known subsequent to instruction.

3. It reflects a sequential coverage of subject matter content and learning experiences in a linear and/or branching format. This third aspect is accommodated in both an individual instructional module and an entire course by way of identifying a knowledge/skills continuum that (a) spans the breadth of coverage appropriate to the topic at hand and (b) reflects a gradual progression in sophistication from the simple to the most complex. The operative principle here is predicated on the desirable establishment of associations among topics and subtopics to be learned in a fashion that adheres to a deductive (general to specific) and/or inductive (specific to general) pattern of reasoning.

4. It evaluates student success in terms of performance standards rather than peer-group rank ordering. This fourth

component of CRMBI is furnished by a reliance on domain- or criterion-referenced test construction whereby the basis for including certain items on a given module test is that of their congruence with the performance objectives specified for that module. The evaluation of the student is then predicated on how his/her behavior compares to the proficiency criteria associated with the originally-targeted domain of performance objectives. The evaluative principle operating here involves the necessity--particularly in high-risk skill areas--of attesting to a student's competence by comparing his/her test performance to the actual real-life performance demands inherent in the job situation to which the instruction was referenced from the outset. The unacceptable alternative which is quite prevalent in many non-CRMBI strategies is that of basing the evaluation of a student on his/her performance rank ordering within the student peer group--sometimes irrespective of the actual competence level attained!

5. It allows for <u>flexible student entry and exit points</u> in the instructional sequence on an individual or small group basis. This fifth and final feature of CRMBI is addressed primarily by the instructional materials development and instructional management provisions that enable students to start and finish any instructional sequence in a staggered fashion. More specifically, the <u>instructional materials development</u> component here ensures (a) entry into an instructional sequence

only when prerequisites are met and (b) exit from the sequence only when established minimal competencies are demonstrated; the instructional management component allows for the unlimited or controlled recycling of a deficient student through the contents of an instructional sequence--unlimited if the student is recycled individually or controlled if the recycling is done in terms of small groups of students. The undergirding principle here is the contention that desirable learning outcomes are not necessarily mastered within certain fixed time parameters simply because such would be administratively convenient; if necessary, the time factor in learning should be allowed to vary--within justifiable limits--if, indeed, this would serve to ensure the constancy of high performance levels.

Variations

Two variations of CRMBI are suggested in the literature governing mastery learning, a highly reputable approach to individualized instruction that has been characterized by Torshen (1977) as one strategy for accommodating competency-based education; hence, its linkage to CRMBI. These two variations are labelled (a) the Learning for Mastery or LFM approach (Bloom, 1968) and (b) the Personalized System of Instruction or PSI strategy (Keller, 1968), and have been reviewed extensively by Block and Burns (1976).

Group-based, teacher-paced. The so-called LFM approach is essentially characterized as a group-based, teacher-paced strategy

in which a teacher and a student group of moderate size (typically, 20-30 students) work under fixed amounts of time available for instruction. In this approach, a definite entry point and an exit point in time for an instructional sequence are identified for the entire group; however, time flexibility between the designated entry and exit points is possible.

Individually-based, student-paced. By way of contrast, the PSI strategy is characterized as an individually-based, student-paced approach in which the individual student is allowed whatever amount of time is needed to attain proficiency in the instructional sequence. In this strategy, entry and exit points in time for a given instructional sequence are not fixed but rather are allowed to vary from individual to individual.

Advantages and disadvantages inherent in each of the two aforementioned variations should be readily apparent. In the group-based, teacher-paced approach, instructional management problems are minimized but potentially at the expense of flexibility in student learning time; in the individual-based, student-paced strategy, flexibility in student learning time is maximized but potentially at the expense of efficient instructional management being jeopardized.

Small group-based, flexibly teacher-paced: A hybrid variation. Perhaps the optimal variation of a CRMBI strategy is one which is hybrid in nature in that it incorporates features of the two approaches mentioned above. More specifically, the format suggested

here is one that is small group-based and flexibly teacher-paced in which, for instance, several small groups of 7-10 students are allowed to enter and exit an instructional sequence in a staggered fashion if need be. Furthermore, the pacing of students in a small group context through a given sequence is governed flexibly by the teacher so as to ensure that basic competencies are indeed met.

With respect to the instructional management issue, the three small groups could be rotated within the classroom during a regular class period of, say, 60 minutes. For any given small group, 20 minutes would be devoted to its receiving didactic instruction or some other form of teacher-directed, group-oriented strategy. The remaining 40 minutes would be spent by the group members working individually or in clusters of 2 or more students.

Regarding the issue of flexibility in student learning time, since two-thirds of any class period would involve a given student having the option of working independently but only as a sequel to the previously-completed direct instruction provided by the teacher, that student would in effect have the latitude (a) to advance beyond the teacher-established pace or (b) to invest additional time in remedial activities. In either case, the individual student--most probably as part of and in conjunction with the small group itself--would announce his/her readiness for competency testing at the conclusion of an instructional sequence.

Conclusions

This paper has endeavored to advance the case for CRMBI as applied to training and educational efforts in business, industrial, and military settings. An appeal was made to the extensive proliferation of the professional literature in this area over the past 20 years, with a particular focus on (a) risk-oriented technical skills and (b) the multitude of diverse training situations to which CRMBI has been directed. Additionally, the logic inherent in (a) the practical and theoretical dynamics of CRMBI and (b) the instructional management variations it may assume was examined.

In the final analysis, it would seem that the case favoring CRMBI is indeed convincing when one considers these three compelling points: (a) its extensive application and consistent effectiveness over an extended period of time; (b) its five essential components as an instructional delivery system that provide for predetermined learner outcomes, prerequisite learner background, instructional sequencing, criterion-referenced evaluation, and flexible student entry and exit points; and (c) its hybrid management variation that is small group-based and flexibly teacher-paced.

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